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Television Antenna Installation

Part 1, Erecting the Fringe-Area Antenna

By the Engineering Department, Aerovox Corporation

THE proper selection and erection of the antenna is one of the most important aspects of the installation of a television receiver. This is particularly true in fringe areas where the signal strength is marginal and a good antenna installation means the difference between high picture quality and "snow". The antenna installation also presents a problem in economics for the television technician, since there is no substitute for quality in this phase of TV servicing. Many customer complaints and repeat service calls may be prevented by a safe and sound initial installation. This issue of the RESEARCH WORKER is therefore devoted to a discussion of the technicalities of television antenna erection and alignment. Part II will contain design and constructional information on a simple instrument for television antenna orientation.

The antenna installation problems confronting the TV technician differ greatly acording to the location of the installation with respect to the transmitter service area. In the primary zone, reflections (ghosts) and omni-directional reception are major problems, while in the fringe areas high gain and low noise pick-up are the main considerations. Since the primary service zone requirements

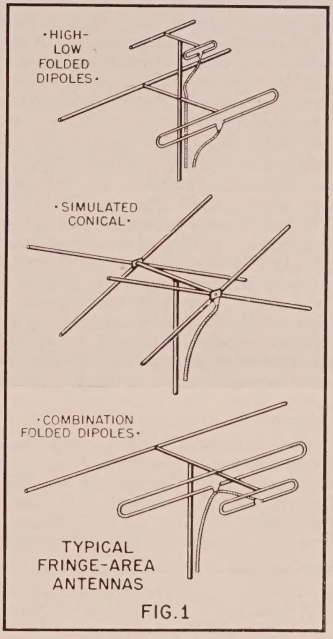

FIG.1

are frequently fulfilled by simple indoor or built-in antennas, the problem of the greatest technical importance lies in the fringe area installation. This is especially true since a given transmitter in a populous area may serve many tiimes as many fringe area receivers as primary zone sets. For this reason, this discussion will be confined generally to the fringe-area installation.

Choosing a Television Antenna

The characteristics required of a TV antenna operating in a weak-signal area are as follows:

(a) High forward gain
(b) High front-to-back gain ratio
(c) Single major lobe directivity on all channels
(d) Low-angle vertical directivity
(e) Low wind resistance
(f) A neat appearance

Not all commercially available antennas meet each of these requirements, although the most popular makes combine a reasonably satisfactory number of them. In general, designs which employ separate antenna for the high and low television bands are capable of giving somewhat better performance than the all-band types, since certain compromises are necessary to achieve operation over the required 4:1 frequency range (54-216 mc.). However, the economy and simplicity of

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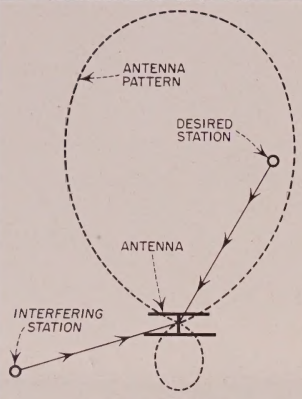


USE OF ROTATOR TO ELIMINATE CO-CHANNEL INTERFERENCE

FIG. 2

the all-channel designs, as well as their thoroughly satisfactory performance, makes them very popular for fringe-area reception. The simplicity of installation and maintenance of a type requiring only one lead-in usually more than compensates for the slight sacrifice in performance.

Multi-element antennas are usually required for adequate reception in remote areas. The unidirectional properties of such designs are also desirable in reducing co-channel interference, which is more bothersome in ringe areas than in primary service zones because the desired signals are weaker and the distance to the interfering station on the same channel may be much shorter. For multi-channel operation, antennas utilizing driven elements and reflectors are the most practical and are almost universally used. Antennas of the "Yagi" design, which use a reflector and one or more director elements are usually not sufficiently broadband to receive more than a single channel.

A practical method of determining a suitable antenna type to use in a given locality (where this choice is left to the installer) consists of surveying the types already in popular use in that area. This usually serves as a reliable guide to the most practical kinds, as indicated by the experience of others. This procedure will also indicate the average mast height required.

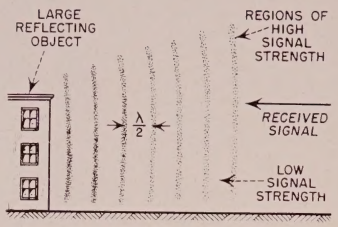
Fig. 1 illustrates a few of the general types of TV antennas which have proven popular for secondary and fringe zone reception. The number of "bays" of these arrays which may be necessary for good reception is proportional to the air-line distance to the transmitter. As many as four bays may be necessary in very remote areas or in locations where intervening objects such as hills result in weak received signals. Vertical "stacking" is usually employed since this serves to lower the angle of maximum sensitivity to the angle just above the horizontal at which line-of-sight television signals arrive. Interference of the type known as "airplane flutter" is also reduced by this measure.

The Use of a Rotator

A problem which sometimes faces the television technician concerns the necessity of incorporating an antenna rotator in the installation. Several makes of reliable electric rotators are available commercially, as well as convenient means of manual rotation in some installations. Whether rotation is a necessity or merely a luxury depends again upon the service zone. In a locality where the transmitting stations lie in various directions, rotation may be required to receive all available stations. This solution is usually preferable to the use of separate antennas for each direction, and certainly has more "landlord appeal".

A rotator is a very useful adjunct to a fringe area TV installation which is frequently bothered by co-channel interference. The ability to rotate the antenna sometimes makes it possible to eliminate the interfering station by placing it in a "null" of the antenna response pattern, as is shown in Fig. 2. The same is frequently true of interference caused by local oscillator radiation from a neighboring television set. A position of the antenna can usually be found which greatly favors the desired signal while rejecting the interfering one.

One interesting system of manual antenna rotation used by a New Jersey experimenter consists of running the antenna mast through an unused fire place chimney. The chimney provides support so that no guying



ILLUSTRATING STANDING WAVES AROUND LARGE OBSTACLES

FIG. 3

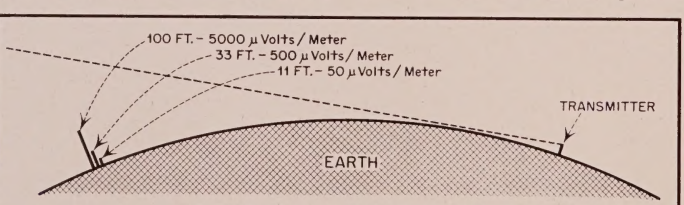
is necessary and rotation is accomplished from the living room by turning the mast in the fire place.

Locating the Mast

The location of the antenna and its supporting mast on the roof or other structure is important from the standpoint of ease of installation and subsequent performance. There are many considerations which the installer must keep in mind if the job is to be a practical one.

If the installation is in a rural area where there is little chance of reflections from large neighboring objects such as buildings or mountains, there is probably no necessity of surveying the site to find a spot of suitable signal strength. In such cases, the location will be dictated by such factors as availability of an anchoring structure, length of lead-in, distance from a highway or other sources of electrical noise, and others. On the other hand, if reflections are present, the actual location of the antenna should be decided by a field strength test.

Reflections cause various effects in television reception, depending upon the distance of the reflecting object. One readily recognized effect of such reflections is "ghost" images, which result when the reflected signal arrives with sufficient time delay to cause two or more identical images to be seen on the picture tube. Reflections from objects which are too close to the antenna to produce



VARIATION OF SIGNAL STRENGTH WITH RECEIVING ANTENNA HEIGHT

FIG. 4

"ghosts" are also important since these cause standing waves in the space surrounding the antenna. If the antenna is located at a *node* of this standing wave pattern, it will receive much less signal than if it were located at an *anti-node*, or maxima. As is shown in Fig. 3, the positions of maximum signal are located one-quarter wavelength on either side of the minima. The importance of determining the antenna position by an actual field test is apparent. This survey may be conducted by using a field-strength meter, or by temporarily connecting the antenna to the set being installed and communicating between the set and the roof with a pair of sound-powered phones.

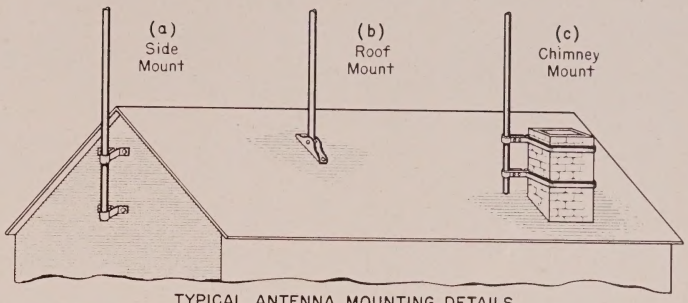
In a fringe service area, the height of the receiving antenna is of extreme importance. For an antenna considerably beyond the normal line-of-sight, the field intensity of the received signal is increased approximately 10 times (10 db) each time the antenna elevation is tripled. Thus an antenna 100 feet high would theoretically intercept 10 times as much signal as one mounted 33 feet high and 100 times as much as one 11 feet from the ground level. See Fig. 4. The increase in signal-to-noise ratio in noisy localities is sometimes even greater, since each foot of altitude removes the antenna from the region of high man-made noise close to the ground.

Fringe area antenna installations range from about 30 to 75 feet in height, with extremes up to several hundred feet in remote mountainous areas. It must be borne in mind that high quality low-loss feedline must be used in such cases to avoid sacrificing most of the gain obtained by height in transmission line losses.

Erecting the Antenna

Raising a large outdoor antenna is a job for at least two men. Few individuals or commercial establishments can risk the personal danger and property damage made possible by attempting to do this work with insufficient help. Most installation crews consist of three men; one to perform the inside installation and two others to assemble the antenna on the ground, attach guy wires and feed lines, install the antenna mounting bracket, and perform other outside work. When these phases are completed, all three concentrate on the erection and securing of the mast.

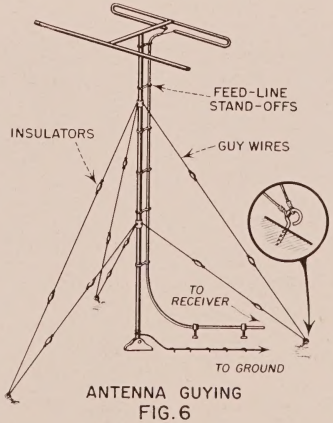
A wide variety of mounting brackets are available for anchoring the antenna mast to its supporting structure. The choice among these depends upon which part of the roof



TYPICAL ANTENNA MOUNTING DETAILS
FIG. 5

the antenna is to be mounted. Representative types are shown in Fig. 5. Mounts which do not require making holes in the roofing, such as the chimney and side mounts, are highly desirable where applicable, since there is less danger of causing expensive roof leaks. However, for most high antenna installations, the mast is mounted near the center of the roof to allow sufficient guying points on the structure. In these cases, a roof mount (Fig. 5b) is employed, and is secured by wood screws or anchor bolts. Each hole is sealed against leaks by applying a liberal coating of asphalt or plastic roofing cement around the screw heads and fittings. Zinc-clad marine hardware is preferable from the standpoint of weather resistance.

The use of guy wires is usually necessary with fringe zone antennas due to the height required. Fig. 6 illustrates the proper method of guying an antenna structure. The wires consist of 6 or 8 strands of No. 16 galvanized wire, and should be broken up with strain insulators at intervals so that the guy wire system does not



ANTENNA GUYING
FIG. 6

act as a ground plane under the antenna and distort its pattern. The guy wires should be fanned out at angles of about 120-degrees. Hooks or screw eyes for anchoring the guys should be placed before the mast is raised, and should be well sealed. These screws should be driven perpendicular to the pull of the guy wires rather than parallel (Fig. 6).

Before raising the antenna, it is good practice to fill the hole in the top of the metal mast with a dab of roofing cement to prevent water entering and also to prevent "howling" in strong winds. This is also done to the ends of antenna elements which are not already closed. The electrical connections to the antenna may be sealed against corrosion with a silicone compound or with roofing cement after the terminal threads have been clinched with a pair of cutting pliers to prevent loosening. Each terminal should be coated *separately*. Do not build up a conducting path between the terminals with materials of unknown electrical properties.

The antenna lead-in should be fastened to the side of the mast with the special stand-off insulators which are available for this purpose. Open wire "twin-lead" should not be allowed to lie closer than about 3 inches from metal surfaces for any appreciable distance, as this will change its impedance. Twin-lead is usually twisted to reduce noise and stray signal pick-up. The use of coaxial cable is recommended in locations where noise is high or where salt fogs cause frequent TV "blackouts". If a rotator is used, enough slack must be provided in the feed-line to allow 360-degree rotation.

Any antenna which even approaches the height of the highest surrounding objects must be provided with a ground connection for safety. A No. 6 copper or aluminum wire bonded to the base of the mast and run to the nearest ground will suffice.

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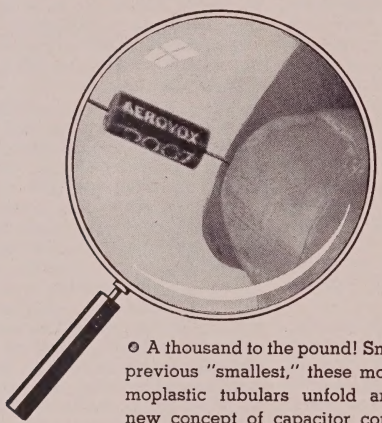

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